REMARKS

Applicants thank the Examiner for thorough examination of the pending claims and thoughtful comments and for granting a telephonic interview subsequently. Applicants will sequentially address the issues raised by the Examiner.

I. Office Action (Feb. 21, 2007) Summary

Claims 13-26 were rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Gallagher, et al., titled, "An efficient 3-D visualization technique for finite element models and other coarse volumes" (hereinafter "Gallagher") in view of Ogden et al., titled, "A Pseudo-Elastic Model for the Mullins Effect in Filled Rubber" (hereinafter "Ogden").
Information Disclosure Statement (IDS) was objected as the non-patent literature denoted within the IDS being allegedly not provided by Applicants.

II. Telephonic Interview Summary (May 17, 2007)

The telephonic interview was conducted amongst the Examiner, Applicants (Paul DuBois and John Hallquist) and the undersigned (representative of the Applicants) on May 17, 2007. No exhibit was used. The present invention was verbally explained and described by Applicants. Claim 13 and Ogden were also discussed. Although there was no definitive agreement reached, the undersigned and Applicants appreciate the opportunity to understand the Examiner's interpretation on the claims.

III. Objection to Information Disclosure Statement (IDS)

A new IDS has been filed on even date with this response. As a result, Applicants respectfully request that the objection

IV. Claim Status Summary

In this response, claims 13, 21 and 24 have been amended. No new matters have been added as the new limitations are supported in the previously

presented and now canceled claim 14 and descriptions in paragraphs [0009] and [0011] of the specification. As a result, claims 13 and 15-26 are pending.

V. The 35 U.S.C. § 103 Rejections

Claims 13-26 were rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Gallagher in view of Ogden. Applicants respectfully traverse the rejections.

A. Brief Comparison between traditional approaches and the Present Invention

During the telephonic interview, a brief comparison between the traditional approaches and the present invention was verbally explained and summarized in this section.

The present invention is different from the traditional approaches for numerically simulating structural response of rubber-like material. The traditional approaches require three distinct steps:

(1) Perform a uni-axial tensile test and sometimes a uni-axial compression test of a specimen or sample of the rubber-like material of interest to obtain engineering strain-stress curve or curves (i.e., experimental results);

(2) Determine a number of unknown coefficients or constants (typically 12 to 24) to define an analytical energy functional (mostly polynomial function) that gives the deformation energy of the rubber-like material in function of stretch ratios λ in three principal directions. This is a lengthy trial-and-error procedure, in which one (i.e., an engineer) needs to guess the coefficients or constants first; then a numerical simulation of the uni-axial test using the guessed coefficients is performed. Finally, the numerical simulation results and the experimental results from

the uni-axial test are compared until a satisfactory correlation is reached; and

(3) Perform a numerical simulation of a structure (e.g., automobile) containing rubber-like material using the final satisfactory result from step (2). The principal stresses of the structure containing rubber-like material are calculated from evaluating the derivative of the energy functional at a particular stretch ratio in each time step.

There are at least two very distinct disadvantages of this procedure: i) it may take at least two and up to several weeks to perform the trial-and-error step (2), even with the aid of an optimization software were used to automate the process; and ii) sometimes even the best estimate of coefficients of the energy functional may not give a perfect fit to the experimental uni-axial test data, which leads to low confidence level as to the actual numerical simulation in step (3).

In contrast to the traditional approaches, the present invention skips step (2) entirely. From the engineering strain-stress curves (i.e., the experimental results) of step (1), the present invention calculates exact corresponding data points of the energy functional and its derivatives. No analytical energy functional is assumed, thereby, no coefficients need to be fitted. As a result of the exact calculation based on the present invention, a lookup table can be pre-calculated with the stress function values. In other words, a lookup table would have been applied in the traditional approaches long ago, if the results could be pre-computed.

B. Independent Claim 13

It is axiomatic that the combination of cited references in a §103 rejection must disclose every element in the rejected claim. MPEP 2143.03. The currently amended claim 13 includes all of the limitations

of the original claim 14 (canceled in this amendment). In addition, specific and distinct feature(s) in the currently amended Claim 13 are set forth below:

> defining a plurality of finite elements in a finite element model representing a structure that contains the rubber-like material;
> obtaining a strain-stress curve of a specimen of the rubber-like material in a uni-axial test to represent the rubber-like material;
> calculating a plurality of stress function $f(\lambda_i)$ values at a plurality of corresponding stretch ratios λ_i of the rubber-like material and associated stress values σ (λ_i-1) defined in the strain-stress curve, wherein the calculating the plurality of stress function is performed without guessing material coefficients, in a trial-and-error manner, to fit the strain-stress curve obtained in the uni-axial test;
> …

(*emphasis added*)

The description in Paragraph [0011] of the specification to support the new features or limitations is listed as follows: "The method eliminates the requirement of fitting a polynomial function; instead $f(\lambda)$ [(i.e., stress function)] is calculated using only a set of the engineering or nominal stress-strain data from a uniaxial loading test for the present invention." It is emphasized that the new limitation includes "wherein the calculating the plurality of stress function is performed without guessing material coefficients, in a trial-and-error manner, to fit the strain-stress curve obtained in the uni-axial test". Applicants respectfully submit that none of cited references discloses, teaches or suggests the calculating the plurality of stress function is performed without guessing material coefficients, in a trial-and-error manner, to fit

the strain-stress curve. The new limitations further distinguish claim 13 from any and all of the cited references.

In the current Office Action (OA), Gallagher was cited to reject the previously presented independent claim 13 by the Examiner. However, the Examiner admitted that "Gallagher fails to teach a plurality of stress functions, strain-stress curves, solving eigensolutions of a deformation gradient tensor, and transforming the principal stress into global coordination system" (lines 11-13 of page 3 in the OA). Ogden was then cited and relied on by the Examiner for the rejection of claim 13. Applicants respectfully disagree with the Examiner based on the remarks below.

a. Overview of Gallagher

   Gallagher discloses a technique that extends exiting 3-D result visualization methods for use with discretized volumes. Gallagher, Abstract. In Gallagher, the technique accomplishes three goals in the visualization of 3-D behavior when results are available on the relatively coarse, non-uniform grid: i) the generation of smooth, non-faceted result surfaces; ii) the processing of single elements within a low-level display loop with minimal stored data; and iii) visual representation of intra-element behavior. Gallagher, Conclusions.

   In the OA, the Examiner asserts that Gallagher teaches: a) finite element analysis, b) rubber-like material and c) lookup table. Applicants submit that while Gallagher mentions the terms such as "finite element analysis", "rubber" and "lookup table", these terms are taken out of context; therefore, Gallagher is not analogous art in the field of mechanical computer aided engineering analysis of rubber-like material.

First, the term “rubber” is mentioned in the following sentence (i.e., first sentence in the paragraph 6, right column of page 191 cited by the Examiner): “Another issue is the smoothing of results across known discontinuities of physical characteristics or result values – for example, when elements of materials such as rubber and steel share common nodes.” There is no teaching about how to calculate or numerically simulate rubber-like material in this sentence, or anywhere in Gallagher. It teaches how to solve an issue when smoothing of results across a known discontinuity. The exemplary materials, instead of steel and rubber, could have been plastics and metal or two other types of material.

As to the term “finite element analysis”, the full sentence in Gallagher, cited by the Examiner, is reproduced here: “Techniques to display these result values on exterior visible surfaces have been available for some time, and are used as a stand tool by finite element analysis.” (page 185, right column, second paragraph, Gallagher) There is no teaching as to how to simulate rubber-like material in a finite element analysis. Only the term of “finite element analysis” is mentioned.

Lastly, the term “lookup table”, was taught by Gallagher to define isosurface for a visualization application not to define or calculate the rubber-like material properties. This is evidently shown in the following quotation from Gallagher: “The lookup tables yield the element edges that intersect the isosurface, and connectivity of the intersection points on the isosurface segments. Another extension used here is that the lookup tables generate 4-corner polygons where possible, …” (2nd paragraph, left column, page 187 Gallagher).

Applicants respectfully submit that Gallagher is not an analogous art with regard to the present invention or for that matter, prior art in the field of numerically simulating rubber-like material.

b. Overview of Ogden

Ogden discloses a pseudo-elastic model for the Mullins effect in filled rubber. Ogden, Title. Further, the model is based on the theory of incompressible isotropic elasticity amended by the incorporation of a single continuous parameter, interpreted as a damage parameter." Ogden, page 2861.

In the OA, the Examiner states that the step "iteratively calculating a plurality of stress function values ..." is taught in Ogden page 2876 equation 5.2[0] (Since there is no equation 5.20 in Ogden, it appears that the Examiner meant equation 5.2, which is listed in page 2876 of Ogden). Applicants respectfully disagree based on the following remarks. In addition, the new features in claim 13 are not disclosed, taught or suggested by Ogden alone or in combination with Gallagher.

1. Ogden teaches the traditional approach

Ogden teaches a pseudo-elastic model for filled rubber including the Mullins effect. The pseudo-elastic model uses the traditional approach described in the section A. of this response. Curves presented in Figure 2 of Ogden cannot be used directly to calculate stress function values. An unknown set of material coefficients must be guessed, in a lengthy trial-and-error manner, to fit the experimental data (e.g., a uni-axial tensile and/or compression test). Equation 5.2 is a special form with a set of material coefficients, which

can only be used for special case. It cannot be applied to a general case that requires a uni-axial test to obtain the material properties. Therefore, Applicants respectfully submit that Gallagher or Ogden, alone or in combination, does not teach, disclose nor suggest the new limitation in claim 13 "the calculating the plurality of stress function is performed without guessing material coefficients, in a trial-and-error manner, to fit the strain-stress curve".

2. Impermissible Hindsight Reconstruction

Improper hindsight reasoning should not be applied in support of an obviousness rejection. MPEP 2145.X.A. Hindsight reasoning is proper if it is only takes into account knowledge which was within the level of ordinary skill in the art at the time the claimed invention was made, but not knowledge gleaned from applicant's disclosure. *Id.*

The Examiner asserts, in the current OA, that "it would have been obvious to a person having ordinary skill in the art at the time of applicants' invention to modify Gallagher in view of Ogden for the purpose of creating a model that is applicable to multiaxial states of stress and strain, not just specific uniaxial test."

Applicants respectfully submit that the reason asserts by the Examiner has no relationship with the claimed invention (i.e., the calculating the plurality of stress function is performed without guessing material coefficients, in a trial-and-error manner, to fit the strain-stress curve obtained in the uni-axial test). The only reference to the limitation "the calculating the plurality of stress function is performed without guessing

material coefficients, in a trial-and-error manner, to fit the strain-stress curve obtained in the uni-axial test" comes from the Application's Specification. Thus, Applicants respectfully submit that the improper hindsight reasoning has been applied to support the obviousness rejection.

Based on the above remarks, Applicants believe that claim 13 shall be allowable. Reconsideration of claim 13 is respectfully requested.

C. Independent Claims 21 and 24

Independent claims 21 and 24 incorporate similar features recited in claim 13 and were also rejected for the similar reasons as for claim 13. Applicants would like to apply the above remarks for claim 13 to support claims 21 and 24 also. Reconsideration of claims 21 and 24 is respectfully requested

D. Claim 14

The limitations recited in the previously presented claim 14 have been included in the currently amended independent claim 13. As a result, claim 14 has been canceled without prejudice in this amendment.

E. Dependent Claims

Dependent claims 15-20 are dependent upon claim 13, claims 22 and 23 are dependent upon claim 21, claims 25 and 26 are dependent upon claim 24, and contain additional limitations further distinguish them from Gallagher or Ogden, viewed alone or in combination. Therefore, claims 15-20, 22, 23, 25 and 26 shall be allowable for at least the reasons stated above with regard to independent claim 13.

Summary

In view of the forgoing remarks, Applicants believe that all claims now pending in this application are in condition for allowance. Early and favorable action is being respectfully solicited.

If there are any issues the Examiner believes that they could be resolved through either a Supplementary Response or an Examiner's Amendment, the Examiner is respectfully requested to contact the undersigned at (408)255-6853.

No fee is required for this amendment, if it is determined that a fee is due in connection with this paper, the Commissioner is hereby authorized to charge payment of any fees associated with this communication or credit any overpayment, to Deposit Account No. 553308, including any filing fees under 37 CFR 1.16 for presentation of extra claims and any patent application processing fees under 37 CFR 1.17.

Respectfully submitted,

I hereby certify that this correspondence is being transmitted to the Commissioner for Patents via the Office electronic filing system on the date stated below.

Date: May 21, 2007

Signature: /Roger H. Chu, Reg.# 52745/
Roger H. Chu

/Roger H. Chu, Reg.# 52745/

Roger H. Chu
Registration No. 52,745